the same and subsequent volumes various memoirs on binary and ternary quantics, including papers (by himself, with the aid of Franklin) containing tables of the numerical generating functions for binary quantics of the first ten orders, and for simultaneous binary quantics of the first four orders, &c. The memoir (vols. ii. and iii.) on "Ternary cubic-form equations" is connected with some early papers relating to the theory of numbers. We have in it the theory of residuation on a cubic curve, and the beautiful chain-rule of rational derivation; viz. from an arbitrary point 1 on the curve it is possible to derive the singly infinite series of points $(1, 2, 4, 5, \ldots 3p \pm 1)$ such that the chord through any two points, m, n, again meets the curve in a point $m + n$, $m \sim n$ (whichever number is not divisible by 3) of the series; moreover, the coordinates of any point m are rational and integral functions of the degree m^2 of those of the point 1.

There is in vol. v. the memoir, "A Constructive Theory of Partitions arranged in three acts, an Interact in two parts, and an Exodion," and in vol. vi. we have "Lectures on the Principles of Universal Algebra" (referring to a course of lectures on multinomial quantity, in the year 1881). The memoir is incomplete, but the general theories of nullity and vacuity, and of the corpus formed by two independent matrices of the same order, are sketched out; and there are in the *Comptes rendus* of the French Academy later papers containing developments of various points of the theory,—the conception of "nivellators" may be referred to.

The last-mentioned paper in the *American Mathematical Journal* was published subsequently to Sylvester's return to England on his appointment as Savilian Professor of Mathematics at Oxford. In December 1886, he gave there a public lecture containing an outline of his new theory of reciprocants (reported in NATURE, January 7, 1887), and the lectures since delivered are published under the title, "Lectures on the Theory of Reciprocants" (reported by J. Hammond), same *Journal* vols. viii. to x.; thirty-three lectures actually delivered, entire or in abstract, in the course of three terms, to a class in the University, with a concluding so-called lecture 34, which is due to Hammond. The subject, as is well known, is that of the functions of a dependent variable, y, and its differential coefficients, $y', y'', \ldots$, in regard to x (or, rather, the functions of $y', y'', \ldots$), which remain unaltered by the interchange of the variables x and y: this is a less stringent condition than that imposed by Halphen ("Thèse," 1878) on his differential invariants, and the theory is accordingly a more extensive one. A passage may be quoted:—"One is surprised to reflect on the change which is come over Algebra in the last quarter of a century. It is now possible to enlarge to an almost unlimited extent on any branch of it. These thirty lectures, embracing only a fragment of the theory of reciprocants, might be compared to an unfinished epic in thirty cantos. Does it not seem as if Algebra had attained to the dignity of a fine art, in which the workman has a free hand to develop his conceptions, as in a musical theme or a subject for painting? Formerly, it consisted in detached theorems, but nowadays it has reached a point in which every properly-developed algebraical composition, like a skilful landscape, is expected to suggest the notion of an infinite distance lying beyond the limits of the canvas." And, indeed, the theory has already spread itself out far and wide, not only in these lectures by its founder, but in various papers by auditors of them, and others,—Elliott, Hammond, Leudesdorf, Rogers, Macmahon, Berry, Forsyth.

Sylvester's latest important investigations relate to the Hamiltonian numbers: there is a memoir, *Crelle*, t. c. (1887), and, by Sylvester and Hammond jointly, two memoirs in the Philosophical Transactions. The subject is that of the series of numbers 2, 3, 5, 11, 47, 923, calculated thus far by Sir W. R. Hamilton in his well-known Report to the British Association, on Jerrard's method. A formula for the independent calculation of any term of the series was obtained by Sylvester, but the remarkable law by means of a generating function was discovered by Hammond, viz. E_0, E_1, E_2, . . . , being the series 3, 4, 6, . . . of the foregoing numbers, each increased by unity; then these are calculated by the formula $(1-t)^{E_0} + t(1-t)^{E_1} + t^2(1-t)^{E_2} + \ldots = 1-2t$, equating the powers of t on the two sides respectively: observe the paradox, $t = \frac{1}{2}$, then the formula gives $0 =$ sum of a series of positive powers of $\frac{1}{2}$.

Enough has been said to call to mind some of Sylvester's achievements in mathematical science. Nothing further has been attempted in the foregoing very imperfect sketch.

A. CAYLEY.

THE CREMATION OF THE DEAD.

The Cremation of the Dead. By Hugo Erichsen, M.D. (Detroit: D. O. Haynes and Co., 1887.)

THIS book is an appeal to the general public on the propriety of introducing the practice of cremation, universally, into civilized communities; or, as the author puts it, "it is a plea for the burning of the dead." He considers, and we are inclined to think he is right, that the period of fanatic and fierce opposition to cremation has passed, and has made way for a calm consideration of the subject. In 1874, he tells us, a Persian gentleman then resident in one of the Eastern States of the free and great Republic of America, who wanted to have his wife cremated, was compelled by an ignorant mob to resort to interment; but now the feeling has changed.

In our own country the same sensible desire to discuss the question of cremation, fully and freely, is fairly established at the present time; and so greatly has prejudice disappeared, that now the act of cremation has been carried out over fifty times at the Woking Cemetery alone. As Sir Spencer Wells shows, in an introductory chapter which he has written for the work before us, the obstacle of law in England against cremation has been removed, and relatives may resort to the cremation of their dead without any unreasonable impediments.

In saying so much in favour of freedom in regard to cremation, we must, however, in this country confine the freedom to the voice of the living. The wishes of the dead, though they may have been delivered up to the last moment in favour of cremation, and may even have been ordered in the will of the deceased, have no legal weight with the survivors. The writer of this article was called, quite recently, to see a lady who had rather suddenly died, to determine that life was actually extinct. She had been haunted with the most terrible fears that she might be buried alive, fears much intensified by the existence in her family of a tradition that one of her relatives had actually been subjected to this awful ordeal. She had directed in her will that she was to be cremated, but her legal adviser, who had himself drawn out the document, discovered that it had no force in regard to the direction of cremation, and two of the nearest relatives having a determined and conscientious objection to the process, the body had to be interred. In this instance every precaution was taken that the body was absolutely dead, and even decomposed, before it was laid in the earth, and to this extent the wishes of the deceased were fulfilled; but the fact that the law does not respond to the wishes of the dead is a point to be remembered by all who would be cremated. The same failure of law seems to be operative in Italy, for we all remember that the final request of the great Garibaldi as to the disposal of his body by fire remains to the present moment disregarded.

Dr. Erichsen must at once receive the credit of having written the best book that has issued from the press on the subject of cremation. It is short and yet full, concise and yet complete. There are eight chapters: the first, a history of cremation; the second, the evils of burial, and the sanitary aspects of incineration; the third, cremation in times of war; the fourth, the processes of modern cremation; the fifth, the medico-legal aspect of incineration, and the objections to cremation; the sixth, burial alive, cremation from an æsthetic and religious point of view; the seventh, the present state of the cremation question.

The introductory letter by Sir Spencer Wells, to which reference has already been made, is an excellent prelude to the chapters above recorded. Sir Spencer Wells has for many years been a staunch and consistent advocate of cremation, and has put it on record that, when the time comes—may it be long delayed!—his body is to be destroyed by fire. He writes, therefore, with authority, as one who has well considered the subject in all its details, and has learned the best and most forcible answers to the many objections that have from time to time been raised against cremation. He quotes the late Dr. Parkes's statement "that neither affection nor religion can be outraged by any manner of disposal of the dead which is done with proper solemnity and respect to the earthly dwelling-places of our friends. The question should be placed entirely on sanitary grounds. Burying in the earth appears certainly to be the most insanitary plan." On the religious side of the question, Wells also adds a strong sentence from the late Lord Shaftesbury, who remarked to him that, if cremation were wrong, "what has become of the blessed martyrs who were burned at the stake in ancient and modern persecutions?"

We turn naturally, as scientific readers, to the section of Dr. Erichsen's work which treats on the sanitary aspect of the subject. This is not, in our view, the strongest part. In it the author has collated the widely reported instances of the spread of epidemics on the opening of burial-places where persons who died of contagious diseases, similar to maladies which have broken out, have been interred. But here three fallacies are suggested. In the first place, it is impossible to accept all the illustrations as illustrations strictly in point and entirely trustworthy—or, for the matter of that, any of the evidence as absolutely trustworthy—seeing that other causes which might have been at work to produce the effects named are not duly eliminated. In the second place, if the instances cited may be accepted as *primâ facie* evidence, they accord imperfectly with other instances, not of exceptional, but of every-day life, in which cemeteries and graveyards holding the remains of those who have died of contagious maladies have been partly or largely opened without any manifestation of the dangers referred to; or in which persons have lived for long series of years in close proximity to graveyards and cemeteries receiving the dead from infectious diseases, and yet have not suffered from those diseases more than others in other localities. There is at the present moment a cemetery near London, from which at times, emanations of the worst kind proceed, indicating that the cemetery is overcharged with dead, and ought at once to be closed; but no epidemic has broken out from it as a centre of contagion. In the third place, the evidence collected by the author, if it were accepted as mainly trustworthy, is not quite *ad rem.* It would be correct in so far as old burial-grounds and old modes of burial are concerned, but it would have no bearing whatever on the earth-to-earth system of burial which our countryman, Mr. Seymour Haden, has done so much to introduce and to perfect.

Dr. Erichsen's answer to these objections would be: Why linger at all over the bodies of the dead? they feel not, neither do they know. "It is of no consequence to the dead whether they rot in earth and originate miasmata, or are transformed by fire into pure white ashes. They feel as little of the process of decay as they do of the flame: their eye is surrounded by the same darkness, whether down in the deep grave or in the glowing light of the crematory furnace. But it is of greatest consequence to us, the living; and the only way to protect ourselves from poisonous infection by our dead is to burn them."

In this one sentence lies, in a scientific sense, the gist of the whole question. If it were true and demonstrable that the only way by which the living can be preserved from the dead is to burn the dead, every true man of science would support the principle of cremation out and out, and the practice would become universal in a very short space of time. Moreover, as Science, like Nature herself, has no morbid sentiments, but goes straight to and for the truth, she would not tarry long in making herself heard. It is just because the voice of Science cannot be so absolute that it demurs or hesitates. Her scholars inquire amongst the living of the day to see if they afford an answer to the important question. They ask: Are the persons whose duty it is to be nearest to the dead immediately after death—the upholsterers and the servants of the cemeteries and graveyards—more liable than others to the infectious diseases from their special occupations? and the answer which comes back is certainly negative. They ask other and similar questions:—How many times has it been known that a medical man in conducting the autopsy of a person who has died of a contagious affection has contracted the disease? How many women of the death-chamber have contracted disease from the dead? These questions also receive a negative answer; and as a matter of course the man of science is, therefore, unable to be dogmatic or to strain a necessity: he cannot clearly recognize, on a "not proven" verdict, the duty of wounding the extremely sensitive feelings of millions of his fellow-men, on a subject that is amongst the most tender of all that pertains to humanity.

Our idea is that in the current state of public opinion, and in the current state of scientific knowledge, it is best to let the public feeling towards cremation work its own way, and to let earth-to-earth burial also have its free course.

Cremation will come partly by necessity, partly by a gradual sentiment in its favour. To force it by conjuring up dangers which do not exist is the very means of arresting it in its progress. We do not say that the work we have had under review is open to too severe criticism on these grounds; on the contrary, it adduces such a number of sound arguments in support of its case, and, on the whole, shows such a just and good weight on its own side, that we commend it as an excellent treatise—we should not improperly say standard treatise—on cremation.

ASSAYING.

Practical Metallurgy and Assaying: a Text-book for the use of Teachers, Students, and Assayers. By Arthur H. Hiorns. Pp. 471, with 91 Illustrations, Appendix, and Index. (London: Macmillan and Co., 1888.)

ASSAYING was a term originally used to denote the estimation, by the agency of heat, of a particular metal in an ore, alloy, or other metallic compound. Since the publication of Agricola's work in 1556, numerous English translations of foreign treatises on the subject have been published. Amongst these may be mentioned the translations of the works of Erker (1629), Barba (1674), and Cramer (1774). Assaying by the dry way has changed so little that the methods and instruments described in these old books might still be successfully used. Since the introduction, however, of the rapid and accurate wet processes, improvements have quickly followed each other, and from a particular ore a larger yield is now obtained than was formerly the case, so that the dry methods are, with a few exceptions, rapidly falling into disuse, as in many cases they do not indicate with sufficient precision the amount of metal actually present in the ore. The modern English literature of assaying is confined to Mitchell's large treatise, and to the chapters given in Percy's works and in Phillips's "Elements of Metallurgy." No small text-book, in which full cognizance is taken of wet processes, has hitherto been published, and a gap in our metallurgical literature has now been well filled by Mr. Hiorns's useful book, which is based on the course of instruction organized at the Royal School of Mines by Prof. W. C. Roberts-Austen, to whom the author, as an old pupil, dedicates his work. In all the Continental Schools of Mines, the instruction is conducted in a most unsatisfactory manner. Large classes rapidly pass through the various assaying processes, all the students working together with military precision at the Professor's word of command. In London, on the other hand, each student works independently, and is not permitted to pass from one metal to another until he can prove that he is able to constantly produce trustworthy results. As a student of the Royal School of Mines, Mr. Hiorns has thus had an excellent training for the task he has undertaken. Besides this, as Principal of the School of Metallurgy at the Birmingham and Midland Institute, he has had ample opportunity of ascertaining the wants of the average student.

Like so many of the text-books of science now published, Mr. Hiorns's book has been arranged to meet the requirements of the Science and Art Department Syllabus. The first part contains a number of experiments for the student to perform in order to elucidate the principles upon which metallurgy is based; the second part contains an account of the methods of assaying by dry methods; whilst the third deals with assaying by wet methods, and includes volumetric analysis and the analysis of furnace gases. The course is very systematically arranged, and it is certain that any student who has performed the experiments enumerated would be thoroughly well grounded in practical metallurgy. And the fact that such a book is now required by a large number of students in evening classes shows what excellent service the Science and Art Department is doing for practical metallurgy throughout the country.

The author discusses several of the newer methods, such as Turner's method of estimating carbon in iron, and alludes to recent researches, such as those of Beringer on the accuracy of the volumetric estimation of copper. He appears, however, to be unacquainted with the newer methods in use on the Continent, and it is to be regretted that he has not consulted the standard works of Balling and of Bruno Kerl, or the careful abstracts of foreign papers published in the Journals of the Chemical Society and of the Iron and Steel Institute. It is to be regretted, too, that there is a want of uniformity in the weights and measures adopted. Grains and grammes, ounces and cubic centimetres, are used indiscriminately. For industrial purposes, it was perhaps necessary that the "grains" should be retained. But, with regard to the "ounces," many assayers, who are familiar with metric measures, have no idea how many ounces make a pint. In the nomenclature and notation, there is also an unfortunate want of uniformity, as is shown by the indiscriminate use of the terms, oil of vitriol and sulphuric acid, carbonate of soda and sodium carbonate, hæmatite and hematite, OH_2 and H_2O, SO_4H_2 and H_2SO_4. The book is remarkably free from typographical errors. The name Fresenius is, however, spelt wrong in places (pp. 174, 183) and "oxide of silica" (p. 312) is a compound unknown to the chemist.

On the whole, the work is an excellent one, and will, no doubt, prove of great service to the teachers and students of classes in practical metallurgy. Chemists generally, accustomed to ordinary laboratory manipulation, will be interested to see how many operations there are, which, while differing from those with which they deal, are capable of affording very trustworthy results. The illustrations are of a very effective character, and are well executed from drawings that have been prepared with an amount of care not usual in figures of this class. Mr. Hiorns's literary style is far from faultless, but his instructions are always perfectly clear, and, to use the words of an old metallurgist, "he writes like one who hath black'd his Fingers and sing'd his Beard in metallick Operations."

B. H. B.